Powered Watercraft

BACKGROUND OF THE INVENTION

1. Technical Field

[01.00] This invention relates generally to powered watercraft, and more particularly to a high speed powered watercraft having one or more hulls with one or more planing surfaces.

2. Description of Related Art

[02.00] Watercraft with one or more M-shaped boat hulls as described in U.S. Patent Nos. 6,250,245 and 6,314,903 overcome certain bow wave concerns. They capture and channel the bow wave in order to suppress it. In sea trials of a boat embodying such a hull, the act of increasing power to test the advantages of the air planing cushion at higher boat speeds led to the discovery of unexpected high speed characteristics. Powered watercraft with one or more M-shaped boat hulls as described in U.S. Patent No. 6,526,903 enhance some of the unexpected high speed characteristics of M-shaped boat hulls. They inject exhaust and/or surplus compressed air from main propulsion engines into the planing channels. Significant performance advantages and reduction of both thermal and acoustical (heat and sound) signatures result, along with military and commercial interest in further improvements. Thus, a need exists for additional high-speed improvements for such powered watercraft.

SUMMARY OF THE INVENTION

[03.00] This invention addresses the need outlined above by venting propulsion engine exhaust at one or more vertical steps in one or more planing surfaces on the watercraft. Doing so introduces gas along the planing surface that significantly improves performance and efficiency. In that regard, the term "planing surface" herein includes planing channel ceilings on M-shaped boat hulls and also other hull surfaces on M-shaped boat hulls and other boat hulls (including displacement body surfaces) that plane at increased speed when the watercraft is under way. The term "vertical step" refers to a drag-reducing step in such a planing surface. So, the invention improves any of various powered watercraft hulls, including M-shaped boat hulls.

[04.00] To paraphrase some of the more precise language appearing in the claims and further introduce the nomenclature used, a watercraft constructed according to the invention includes at least one hull (i.e., one or more) and an onboard propulsion engine (e.g., diesel, turbine, or other exhaust-producing propulsion engine onboard the watercraft). The hull includes at least one planing surface (i.e., one or more), and the planing surface includes at least one vertical step (i.e., one or more). The vertical step is an abrupt, drag-reducing variation in planing surface level that is a well known structure. Vertical steps properly designed and located across the planing surface of a hull serve to break the increasing friction drag on the planing surface in a known manner.

[05.00] According to the major aspect of the invention, means are provided onboard the watercraft for venting exhaust and surplus compressed air from the onboard propulsion engine at the vertical step in the planing surface while under way in order to introduce gas along the planing surface (preferably high temperature gas). In one embodiment, the vertical step in the planing surface includes an upper portion and a lower portion, the hull defines an exhaust-venting opening intermediate the upper and lower portions of the vertical step, and the means for venting exhaust from the onboard propulsion engine at the vertical step includes an exhaust-venting system extending to the exhaust-venting opening. Single-hull and multiple-hull watercraft versions are described, along with multiple planing surfaces and multiple vertical steps. The means for venting exhaust is arranged to vent exhaust at one or more of the multiple vertical steps.

[06.00] Preferably, the exhaust-venting opening at the vertical step is located intermediate the upper and lower portions of the vertical step where it faces rearwardly from the vertical step. That arrangement results in pressurized exhaust gases being directed parallel to and adjacent to the planing surface in order to create a film of high pressure gas that provides lift and further reduces friction drag. In addition, the entering gas creates a venturi effect that reduces the back pressure and its adverse effect on engine efficiency. Alternately, the exhaust-venting opening may be located in the upper portion of the vertical step and face downwardly from the upper portion, within the scope of the broader claims. In one embodiment, the planing surface includes multiple vertical steps and the planing surface retracts after each of the multiple vertical steps toward an original planing

surface level. In another embodiment, the planing surface includes multiple vertical steps and the planing surface is elevated after each of the multiple vertical steps from an original planing surface level.

[07.00] Thus, the invention in all of its variations significantly improves performance and efficiency of the M-shaped boat hull with a structural improvement that applies to other powered watercraft having other forms of hulls with planing surfaces. The following illustrative drawings and detailed description make the foregoing and other objects, features, and advantages of the invention more apparent.

BRIEF DESCRIPTION OF THE DRAWINGS

[08.00] FIG. **1** of the drawings is a starboard side elevation view of a first watercraft constructed according to the invention that includes an M-shaped boat hull with vertical steps in the central displacement hull and the planing channels;

[09.00] FIG. **2** is a diagrammatic plan view of the underside of the first watercraft showing the extension of the vertical steps that covers the entire central displacement body and the planing channels;

[10.00] FIG. **3** is a diagrammatic view of the first watercraft similar to FIG. **2** that shows the exhaust-venting system for directing propulsion engine exhaust into the vertical steps;

[11.00] FIG. **4** is a starboard side elevation view of the first watercraft similar to FIG. **1** that includes the propulsion engine and the exhaust-venting system gas ducts leading into the vertical steps;

[12.00] FIG. **5a** is a diagram depicting an enlarged isometric view of a portion of the starboard side, the planing surface, and a vertical step of watercraft such that the exhaust-venting opening is located in the riser portion of the vertical step;

[13.00] FIG. **5b** is a diagram similar to FIG. **5a** of an alternate exhaust-venting arrangement such that the exhaust-venting opening is located in the upper portion of the vertical step;

[14.00] FIG. **6** is a diagrammatic starboard side elevation view of portions of a second watercraft constructed according to the invention that includes multiple vertical steps and an accompanying exhaust-venting system such that the planing level is raised at each step progressively;

[15.00] FIG. **7** is a diagrammatic starboard side elevation view of portions of a third watercraft constructed according to the invention that includes multiple vertical steps and an accompanying exhaust-venting system such that the planing level retracts after each step to the original planing surface;

[16.00] FIG. **8** is a diagrammatic plan view similar to FIG. **2** of the underside of a fourth watercraft having multiple hulls and multiple vertical steps in each hull; and

[17.00] FIG. **9** is a diagrammatic plan view of the fourth watercraft that includes the exhaust-venting system for directing propulsion engine exhaust into the vertical steps.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[18.00] FIGS. **1-4** of the drawings show various aspects of a powered watercraft **10** constructed according to the invention. Although the invention applies to other than M-shaped boat hulls, the watercraft **10** includes an M-shaped boat hull **11** having a port side **12** (FIGS. **2** and **3**) and a starboard side **13** (FIGS. **1-4**). The hull **11** includes a central displacement body **14** having a planing surface **15** (FIGS. **1-4**), a port channel ceiling **16** having a planing surface **17**, and a starboard channel ceiling **18** having a planing surface **19**. FIGS. **1** and **4** include the static water line **11A** and three arrows depicting the flow of air when the watercraft **10** is under way. Additional details of the M-shaped boat hull aspects of the watercraft **10** may be had by reference to U.S. Patent Nos. 6,250,245; 6,314,903; and 6,526,903.

[19.00] In line with the major aspect of the invention, the watercraft **10** includes a first vertical step **20** (FIGS. **1-4**) in the planing surface **15** of the

central displacement body **14**. The displacement body **14** portion of the hull **11** defines an exhaust-venting opening **20A** at the first vertical step **20**. The watercraft **10** also includes a second vertical step **21** in the planing surface **17** of the port channel ceiling **16** (FIGS. **2** and **3**), and a third vertical step **22** in the planing surface **19** of the starboard channel ceiling **18** (FIGS. **1-4**). The hull **11** defines a second exhaust-venting opening **21A** at the second vertical step **21** (FIGS. **2** and **3**) and a third exhaust-venting opening **22A** at the third vertical step **22** (FIGS. **1-4**). In that regard, the size of the vertical steps **20**, **21**, and **22** and the size of the exhaust-venting openings **20A**, **21A**, and **22A** are not illustrated to scale. They are exaggerated for illustrated purposes in order to better identify them in the drawings.

[20.00] An onboard propulsion engine **23** (FIGS. **3** and **4**) powers the watercraft **10**. It may take any of various known forms, including diesel, gas turbine, and jet engines, and it produces exhaust and surplus air that is conveyed by an exhaust-venting system **24** to the exhaust-venting openings **20A**, **21A**, and **22A**. The exhaust-venting system **24** extends from the engine **23** to the exhaust-venting openings **20A**, **21A**, and **22A**. It includes first, second, and third exhaust manifold branches **25**, **26**, and **27**, each of which conveys exhaust from the engine **23** (e.g., via triangularly shaped ducts) to a respective one of the first, second, and third exhaust-venting openings **20A**, **21A**, and **22A**. Stated another way, the exhaust-venting system **24** functions as means for venting exhaust from the onboard propulsion engine **23** at the vertical steps **20**, **21**, and **22** in the planing surfaces **15**, **17**, and **19** while under way in order to

introduce gas along the planing surfaces. The high temperature of pressurized exhaust gas results in a film of high pressure gas along the planing surfaces **15**, **17**, and **19** that further reduces the friction drag for increased performance and efficiency.

[21.00] FIGS. **5a** and **5b** are diagrams that show further details of the exhaust-venting opening configuration. First consider FIG. **5a**. It depicts an enlarged perspective view (not to scale) of the third vertical step **22** in the planing surface **19** adjacent the starboard side **13** of the hull **11**. The vertical step **22** includes a forwardly disposed lower portion **19A** at a first planing surface level of the planing surface **19** and a rearwardly disposed upper portion **19B** at a second planing surface level of the planing surface **19** that is elevated relative to the first planing surface level by the height of a riser portion **19C** of the third vertical step **22**. The riser portion **19C** defines the exhaust-venting opening **22A** so that the exhaust-venting opening **22A** faces rearwardly. In other words, the hull **11** defines an exhaust-venting opening **22A** intermediate the upper and lower portions **19A** and **19B** that faces rearwardly from the vertical step **22**. This is a preferred orientation.

[22.00] FIG. **5b** illustrates that other opening orientations may be employed within the scope of the broader claims. It depicts an enlarged perspective view of a vertical step **30** in a planing surface **31** of a hull **32**. The vertical step **30** is similar in some respects to the third vertical step **22** illustrated in FIG. **5a** in that it includes a forwardly disposed lower portion **33** at a first planing surface level of the planing surface **31** and a

rearwardly disposed upper portion **34** at a second planing surface level of the planing surface **31** that is elevated relative to the first planing surface level by the height of a riser portion **35** of the vertical step **30**. The major difference is that the upper portion **34** defines an exhaust-venting opening **36** that faces downwardly, with exhaust being vented through it downwardly. In other words, the hull **32** defines an exhaust-venting opening **36** in the upper portion **34** that faces downwardly from the upper portion **36**. Based upon the foregoing and subsequent descriptions, one of ordinary skill in the art can readily practice the invention.

[23.00] Turning now to FIG. **6**, shows a portion of a hull **40** that illustrates one type of vertical step configuration. The hull **40** represents the hull of any powered watercraft. It has a planing surface **41**, a forwardly disposed first vertical step **42** and a rearwardly disposed second vertical step **43**. The hull **40** defines first and second exhaust-venting openings **44** and **45** through which exhaust manifold branches **46** and **47** vent exhaust. The small circles in FIG. **6** represent exhaust and surplus air venting through the exhaust-venting openings **44** and **45**. In this vertical step configuration, the planing level is raised at each of the first and second vertical steps **42** and **43** progressively from an original planing level identified by the broken line at reference numeral **48**.

[24.00] FIG. **7** shows a portion of a hull **50** that illustrates another type of vertical step configuration. The hull **50** has a planing surface **51**, a forwardly disposed first vertical step **52** and a rearwardly disposed second vertical step **53**. The hull **50** defines first and second exhaust-venting

openings **54** and **55** through which exhaust manifold branches **56** and **57** vent exhaust. The small circles represent exhaust and surplus air venting through the exhaust-venting openings **54** and **55**. In this vertical step configuration, the planing level **51** raises at each of the first and second vertical steps **52** and **53** from an original planing level identified by the broken line at reference numeral **58**, only to quickly return to the original planing level.

[25.00] FIG. **8** is a diagram depicting the underside of a multiple hull watercraft **60** constructed according to the invention. It includes a first hull **61** and a second hull **62**. The first hull **61** includes a central displacement body **61A** with a planing surface **61B**, an inwardly disposed first channel ceiling **61C** with a planing surface **61D**, and an outwardly disposed second channel ceiling **61E** with a planing surface **61F**. Similarly, the second hull **62** includes a central displacement body **62A** with a planing surface **62B**, an inwardly disposed first channel ceiling **62C** with a planing surface **62D**, and an outwardly disposed second channel ceiling **61E** with a planing surface **61F**. Each planing surface includes two vertical steps arranged in line to span the width of the planing multiple surfaces. Just the six vertical steps **63**, **64**, **65**, **66**, **67**, **68** are identified for the three planing surfaces **62B**, **62D**, and **62F** of the second hull **62** for illustrative convenience.

[26.00] FIG. **9** shows the watercraft **60** with first and second propulsion engines **60A** and **60B** connected to the vertical steps via first and second exhaust-venting systems **60C** and **60D**. In other words, the invention

applies to powered watercraft with multiple hulls and with multiple vertical steps in each planing surface. It is not restricted to single hull M-shaped boat hulls. In that regard, the term "M-shaped boat hull" herein refers to a boat hull that falls within the scope of one or more of the claims in U.S. Patent Nos. 6,250,245; 6,314,903; and 6,526,903, and those patents are incorporated herein by reference for all of the details they provide.

[27.00] Thus, the invention provides a powered watercraft that vents propulsion engine exhaust at one or more vertical steps in one or more planing surfaces on the watercraft. Doing so introduces gas along the planing surface (preferably high temperature gas) that significantly improves performance and efficiency. Although exemplary embodiments have been shown and described, one of ordinary skill in the art may make many changes, modifications, and substitutions without necessarily departing from the spirit and scope of the invention.

[28.00] What is claimed is: